Application No.: 10/591,456

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## AMENDMENT TO THE SPECIFICATION

**Please amend the paragraph beginning on page 1, line 13 as follows:**

[0003] In order to achieve a small-size microphone, an electret condenser microphone was proposed recently which uses as the electret element a silicon [[oxide]] dioxide film processed by a microfabrication technology rather than the organic high-molecular polymers (see Patent Document 1). Specifically, in this electret condenser microphone, two silicon substrates are joined to each other as a condenser, an electret film formed of a silicon [[oxide]] dioxide film as an electret material is arranged at one of the substrates.

Patent Document 1: Japanese Patent Application Laid Open Publication No. 11-331988A

**Please amend the paragraph beginning on page 1, line 23 as follows:**

[0005] Namely, with a silicon [[oxide]] dioxide film as an electret, which functions to absorb moisture or the like in the air, charge dissipates from the electret. Also, only such a ~~modificatin~~ modification to form a silicon [[oxide]] dioxide film cannot attain an electret with no chronological change. Further, when the electret is heated, the charge dissipates from an exposed part of the silicon [[oxide]] dioxide film. Since the charge of the electret dissipates from the exposed part of the silicon [[oxide]] dioxide film, for example, in mounting the microphone with the electret condenser to another substrate by a reflow process, the microphone is inhibited from sufficiently displaying its function.

**Please amend the paragraph beginning on page 2, line 18 as follows:**

[0009] In the first or second electret condenser, the first insulting film may be a silicon [[oxide]] dioxide film grown in an atmosphere at a temperature in a range between 500 °C and 800 °C, both inclusive.

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**Please amend the paragraph beginning on page 3, line 3 as follows:**

[0012] In the present invention, the electretized first insulating film, which is a silicon [[oxide]] dioxide film or the like that has become an electret by electro-depositing charge, is covered with, for example, the second insulating film of a silicon nitride film or the like or the second insulating film and the second electrode. Accordingly, absorption of moisture and the like in the air by the first insulating film and dissipation of the charge from the first insulting film at heating can be suppressed. Hence, an electret condenser excellent in reliability, such as moisture resistance, thermal resistance can be provided.

**Please amend the paragraph beginning on page 3, line 16 as follows:**

[FIG. 3] FIG. 3(a) is a section showing a structure of a film used in verification of effects obtained by covering an electretized silicon [[oxide]] dioxide film with other insulating films in the electret condenser according to the embodiment of the present invention, and FIG. 3(b) is a section showing a film structure where an electretized silicon [[oxide]] dioxide film is exposed to an atmosphere, which is used as a comparative example in the above verification.

***Please amend the paragraph beginning on page 3, line 24 as follows:***

**Explanation of Reference Numerals**

[0014] 1 resin substrate
2 electret condenser
3 IC
4 shielding case
4a opening
5 vibrating electrode
6 fixed electrode
6a acoustic hole
7 silicon [[oxide]] dioxide film

| | |
|---|---|
| 8 | silicon nitride film |
| 9 | silicon nitride film |
| 10 | conductive film |
| 11 | silicon substrate |
| 15 | bonding wire |
| 21 | substrate |
| 22 | cavity |
| 23 | insulating film |
| 24 | air gap |
| 30 | vibrating film |

**Please amend the paragraph beginning on page 5, line 3 as follows:**

[0019] Specifically, on a substrate 21 arranged on the resin substrate 1 and having a cavity 22, the vibrating electrode 5 is formed so as to cover the cavity 22. An electretized silicon [[oxide]] dioxide film 7 (a film that has become an electret by being charged) is formed on the vibrating electrode 5 with a silicon nitride film 9 interposed therebetween. The silicon [[oxide]] dioxide film 7 is arranged on the central part of the vibrating electrode 5. Further, a silicon nitride film 8 is formed so as to cover the silicon [[oxide]] dioxide film 7. Accordingly, the silicon [[oxide]] dioxide film 7 is completely covered with the silicon nitride film 8 and the silicon nitride film 9. In the present embodiment, the vibrating electrode 5, the silicon nitride film 9, the silicon [[oxide]] dioxide film 7, and the silicon nitride film 8 vibrate integrally to serve as a vibrating film 30.

**Please amend the paragraph beginning on page 5, line 13 as follows:**

[0020] The fixed electrode 6 is formed above the vibrating film 30 with an insulating film 23 serving as a spacer interposed therebetween. In other words, the silicon [[oxide]] dioxide film 7 covered with the silicon nitride films 8 and 9 and an air gap 24 formed by partially removing the insulating film 23 intervene between the vibrating electrode 5 and the fixed

electrode **6**. In the fixed electrode **6**, a plurality of acoustic holes **6a** are formed so as to communicate with the air gap **24**. Further, an opening **4a** is formed at a part of the shielding case **4** facing the fixed electrode **6** so that the acoustic holes **6a** receive sound pressure from the external space.

**Please amend the paragraph beginning on page 5, line 25 as follows:**

[0022] As shown in FIG. **2(a)**, the vibrating film **30** may be formed in such a manner that the electrified silicon [[oxide]] <u>dioxide</u> film **7** is formed on the vibrating electrode **5** and the silicon nitride film **8** is formed so as to cover this silicon [[oxide]] <u>dioxide</u> film **7**.

**Please amend the paragraph beginning on page 6, line 1 as follows:**

[0023] Alternatively, as shown in FIG. **2(b)**, the vibrating film **30** may be formed in such a manner that the silicon nitride film **9** is formed on the vibrating electrode **5**, the electrified silicon [[oxide]] <u>dioxide</u> film **7** is formed thereon, and then, the silicon nitride film **8** is formed so as to cover this silicon [[oxide]] <u>dioxide</u> film **7**.

**Please amend the paragraph beginning on page 6, line 5 as follows:**

[0024] In the vibrating film **30** shown in FIG. **2(a)**, the electret formed of the electrified silicon [[oxide]] <u>dioxide</u> film **7** is completely covered with the vibrating electrode **5** and the silicon nitride film **8**. As to the vibrating film **30** shown in FIG. **2(b)**, the electret formed of the electrified silicon [[oxide]] <u>dioxide</u> film **7** is completely covered with the silicon nitride film **9** and the silicon nitride film **8**. Either structures shown in FIG. **2(a)** or FIG. **2(b)** attain

suppression of absorption of moisture in the air by the silicon [[oxide]] dioxide film 7 and of dissipation of charge from the silicon [[oxide]] dioxide film 7 at heating.

**Please amend the paragraph beginning on page 6, line 12 as follows:**

[0025] The present inventors carried out an experiment for verifying the effects obtained by completely covering the silicon [[oxide]] dioxide film 7 with the vibrating electrode **5** and the silicon nitride film **8** or with the silicon nitride film **9** and the silicon nitride film **8**, as shown in FIG. **2(a)** or FIG. **2(b)**. The results of the experiment will be described with reference to FIG. **3(a)** and FIG. **3(b)**.

**Please amend the paragraph beginning on page 6, line 17 as follows:**

[0026] FIG. **3(a)** is a section showing a structure of a film used in the verification of the effects obtained by completely covering the electrified silicon [[oxide]] dioxide film 7 with the silicon nitride films **8** and **9** in the electret condenser **2** of the present embodiment. FIG. **3(b)** is a section showing a film structure where the electrified silicon [[oxide]] dioxide film 7 is exposed to an atmosphere, as a comparative example in the aforementioned verification. In each film structure in FIG. **3(a)** or FIG. **3(b)**, the silicon [[oxide]] dioxide film **7** is formed on the obverse face of a silicon substrate **11**, on the reverse face of which a conductive film (Al film) **10** is formed.

**Please amend the paragraph beginning on page 6, line 25 as follows:**

[0027] Specifically, the silicon [[oxide]] dioxide film 7 is an LP-TEOS (low pressure-tetraethylorthosilicate) film formed under reduced pressure to have a thickness of 1.5 μm. It is

noted that the temperature for forming the silicon [[oxide]] <u>dioxide</u> film 7 by, for example, reduced pressure CVD (Chemical Vapor Deposition) is preferably set in the range between 500 °C and 800 °C, both inclusive.

**Please amend the paragraph beginning on page 7, line 3 as follows:**

[0028] Further, in the film structure shown in FIG. **3(a)**, the above-described silicon [[oxide]] <u>dioxide</u> film **7** is completely covered with the silicon nitride films **8** and **9**, which are LP-SiN films formed under reduced pressure. Thus, with the use of the LP-SiN films formed by, for example, reduced pressure CVD at a high temperature as the silicon nitride films **8** and **9**, the silicon nitride films **8** and **9** can serve as dense protection films with no pin hole and the like. Specifically, the temperature for growing the silicon nitride films **8** and **9** by, for example, reduced pressure CVD is preferably set in the range between 600 °C and 800 °C, both inclusive.

**Please amend the paragraph beginning on page 7, line 11 as follows:**

[0029] The verification by the present inventors shows that in the film structure in which the silicon [[oxide]] <u>dioxide</u> film **7** to which charge is electro-deposited is exposed to the atmosphere (i.e., the film structure of the comparative example shown in FIG. **3(b)**), a 44-hour shelf test reduced the amount of electrodeposition of the silicon [[oxide]] <u>dioxide</u> film **7** by approximately 8 dB. In contrast, in the film structure in which the silicon [[oxide]] <u>dioxide</u> film **7** to which charge is electro-deposited is completely covered with the silicon nitride film **8** and the silicon nitride film **9** (i.e., the film structure of the present embodiment ~~showin~~ <u>shown</u> in FIG. **3(a)**), the reduced amount of electrodeposition of the silicon [[oxide]] <u>dioxide</u> film **7** was only approximately 0.4 dB after the **44**-hour shelf test, for example. Further, even after the film

structure of the present embodiment additionally underwent one-hour heating in an atmosphere at a temperature of 150 °C, the amount of electrodeposition of the silicon [[oxide]] dioxide film 7 was reduced by approximately 0.1 dB at utmost. In other words, with the film structure of the present embodiment, remarkable suppression can be observed in absorption of moisture and the like in the air by the silicon [[oxide]] dioxide film 7 and in charge dissipation from the silicon [[oxide]] dioxide film 7 at heating, compared with the film structure of the comparative example.

**Please amend the paragraph beginning on page 7, line 27 as follows:**

[0030] As described above, in the present embodiment, the electretized silicon [[oxide]] dioxide film 7 is covered with the silicon nitride films **8** and **9** or with the silicon nitride film **8** and the vibrating electrode **5**, so that absorption of moisture and the like in the air by the silicon [[oxide]] dioxide film **7** and charge dissipation from the silicon [[oxide]] dioxide film **7** at heating can be suppressed. Hence, an electret condenser **2** excellent in reliability, such as moisture resistance and thermal resistance can be provided.

**Please amend the paragraph beginning on page 8, line 6 as follows:**

[0031] The principal of resonance frequency control for the vibrating film **30** will be described below by referring as an example to the case where the vibrating film **30** of the present embodiment is composed of the silicon [[oxide]] dioxide film **7** formed of a LP-TEOS film, the silicon nitride films **8** and **9** formed of LP-SiN films, and the vibrating electrode **5** formed of a polysilicon film (a so-called polysilicon-doped film) to which an impurity is doped (see FIG.**2(b)**).

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**Please amend the paragraph beginning on page 9, line 10 as follows:**

[0035] For example, on the assumption that: an area of the quadratic film to be the vibrating film **30** is 1 $mm^2$ (a = 1mm); the film thickness d1 of the LP-TEOS film to be the silicon [[oxide]] dioxide film 7 (stress ($\sigma1$ in (Expression 7)): -110 x $10^6$ [$N/m^2$] and density ($\rho1$ in (Expression 8)): 2.5 x $10^3$ [$kg/m^3$]) is 1500 nm; each film thickness d2 of the LP-SiN films to be the silicon nitride films **8** and **9** (stress ($\sigma2$ in (Expression 7)): 1200 x $10^6$ [$N/m^2$] and density ($\rho2$ in (Expression 8)): 3.1 x $10^3$ [$kg/m^3$]); and a film thickness d3 of the polysilicon film to be the vibrating electrode **5** (stress ($\sigma3$ in (Expression 7)): -0.3 [$N/m^2$] and density ($\rho3$ in (Expression 8)): 2.3 x $10^3$ [$kg/m^3$] is 200 nm, the resonance frequency f is calculated to be 178 kHz from (Expression 1) through (Expression 8). Accordingly, when the LP-TEOS film and the LP-SiN films are changed in thickness on the basis of this value as a standard resonance frequency f0, the resonance frequency f can be controlled.

**Please amend the paragraph beginning on page 9, line 22 as follows:**

[0036] As shown in FIG. 1, the electret condenser 2 of the present embodiment serves as a component part of the microphone. The microphone changes sound pressure to an electric ~~singal~~ signal in the frequency band of 2 to 20 kHz, which is the audible region. Accordingly, the vibrating film **30** of the electret condenser **2** must have a resonance frequency f higher than 20 kHz, the upper limit of the frequency band. Otherwise, it exhibits insufficient sensitivity to be of no use as a component part of the microphone. In the present embodiment, as described above, when each film thickness of the silicon [[oxide]] dioxide film 7 and the silicon nitride films **8** and **9**, which compose the vibrating film **30**, is adjusted, the vibrating film **30** having a resonance frequency f over 20 kHz can be formed.

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**Please amend the paragraph beginning on page 10, line 8 as follows:**

[0038] As described above, according to the present embodiment, control of each film thickness of the multilayer film (the silicon [[oxide]] <u>dioxide</u> film **7**, the silicon nitride films **8** and **9**, and the like) composing the vibrating film **30** leads to control of the resonance frequency f of the vibrating film **30**.

**Please amend the paragraph beginning on page 10, line 12 as follows:**

[0039] It should be noted that it is preferable that the silicon [[oxide]] <u>dioxide</u> film **7** is set smaller in shape in plan than, for example, the quadratic film to be the vibrating film **30** and is arranged at the central part of the vibrating film **30**. This allows the silicon [[oxide]] <u>dioxide</u> film **7** which is to be an electret to be used as a mass (a weight) in the vibrating film **30**, enhancing the sensitivity of the electret condenser **2** of the present embodiment. Further, the film thickness of the multilayer film composing the vibrating film **30** can be reduced in a region where the silicon [[oxide]] <u>dioxide</u> film **7** is not formed.

**Please amend the paragraph beginning on page 10, line 19 as follows:**

[0040] Moreover, in the present embodiment, the silicon [[oxide]] <u>dioxide</u> film **7** is used as an electret, but the electret may be another insulating film made of polytetrafluoroethylene, FEP, or the like.

**Please amend the paragraph beginning on page 10, line 22 as follows:**

[0041] In addition, the silicon nitride films **8** and **9** are used as the insulating films for covering the electret formed of the silicon [[oxide]] <u>dioxide</u> film **7** in the present embodiment, but other insulting films made of polyimide, benzocyclobutene, or the like may be used instead.